

SEQUENCE LISTING

<110> BASF Aktiengesellschaft

<120> Modified cytochrome P450 monooxygenases

<130> M/40434

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<170> PatentIn Ver. 2.1

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<213> Bacillus megaterium

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| 1 5 10 15 | |
| aat tta ccg tta tta aac aca gat aaa ccg gtt caa gct ttg atg aaa | 96 |
| Asn Leu Pro Leu Leu Asn Thr Asp Lys Pro Val Gln Ala Leu Met Lys | |
| 20 25 30 | |
| att gcg gat gaa tta gga gaa atc ttt aaa ttc gag gcg cct ggt cgt | 144 |
| Ile Ala Asp Glu Leu Gly Glu Ile Phe Lys Phe Glu Ala Pro Gly Arg | |
| 35 40 45 | |
| gta acg cgc tac tta tca agt cag cgt cta att aaa gaa gca tgc gat | 192 |
| Val Thr Arg Tyr Leu Ser Ser Gln Arg Leu Ile Lys Glu Ala Cys Asp | |
| 50 55 60 | |
| gaa tca cgc ttt gat aaa aac tta agt caa gcg ctt aaa ttt gta cgt | 240 |
| Glu Ser Arg Phe Asp Lys Asn Leu Ser Gln Ala Leu Lys Phe Val Arg | |
| 65 70 75 | |
| gat ttt gca gga gac ggg tta ttt aca agc tgg acg cat gaa aaa aat | 288 |
| Asp Phe Ala Gly Asp Gly Leu Phe Thr Ser Trp Thr His Glu Lys Asn | |
| 80 85 90 95 | |
| tgg aaa aaa gcg cat aat atc tta ctt cca agc ttc agt cag cag gca | 336 |
| Trp Lys Lys Ala His Asn Ile Leu Leu Pro Ser Phe Ser Gln Gln Ala | |
| 100 105 110 | |
| atg aaa ggc tat cat gcg atg atg gtc gat atc gcc gtg cag ctt gtt | 384 |
| Met Lys Gly Tyr His Ala Met Met Val Asp Ile Ala Val Gln Leu Val | |
| 115 120 125 | |
| caa aag tgg gag cgt cta aat gca gat gag cat att gaa gta ccg gaa | 432 |
| Gln Lys Trp Glu Arg Leu Asn Ala Asp Glu His Ile Glu Val Pro Glu | |
| 130 135 140 | |
| gac atg aca cgt tta acg ctt gat aca att ggt ctt tgc ggc ttt aac | 480 |
| Asp Met Thr Arg Leu Thr Leu Asp Thr Ile Gly Leu Cys Gly Phe Asn | |

| 145 | 150 | 155 | |
|---|-----|-----|------|
| tat cgc ttt aac agc ttt tac cga gat cag cct cat cca ttt att aca | | | 528 |
| Tyr Arg Phe Asn Ser Phe Tyr Arg Asp Gln Pro His Pro Phe Ile Thr | | | |
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| agt atg gtc cgt gca ctg gat gaa gca atg aac aag ctg cag cga gca | | | 576 |
| Ser Met Val Arg Ala Leu Asp Glu Ala Met Asn Lys Leu Gln Arg Ala | | | |
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| aat cca gac gac cca gct tat gat gaa aac aag cgc cag ttt caa gaa | | | 624 |
| Asn Pro Asp Asp Pro Ala Tyr Asp Glu Asn Lys Arg Gln Phe Gln Glu | | | |
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| gat atc aag gtg atg aac gac cta gta gat aaa att att gca gat cgc | | | 672 |
| Asp Ile Lys Val Met Asn Asp Leu Val Asp Lys Ile Ile Ala Asp Arg | | | |
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| aaa gca agc ggt gaa caa agc gat gat tta tta acg cat atg cta aac | | | 720 |
| Lys Ala Ser Gly Glu Gln Ser Asp Asp Leu Leu Thr His Met Leu Asn | | | |
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| gga aaa gat cca gaa acg ggt gag ccg ctt gat gac gag aac att cgc | | | 768 |
| Gly Lys Asp Pro Glu Thr Gly Glu Pro Leu Asp Asp Glu Asn Ile Arg | | | |
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| tat caa att att aca ttc tta att gcg gga cac gaa aca aca agt ggt | | | 816 |
| Tyr Gln Ile Ile Thr Phe Leu Ile Ala Gly His Glu Thr Thr Ser Gly | | | |
| | 260 | 265 | 270 |
| ctt tta tca ttt gcg ctg tat ttc tta gtg aaa aat cca cat gta tta | | | 864 |
| Leu Leu Ser Phe Ala Leu Tyr Phe Leu Val Lys Asn Pro His Val Leu | | | |
| | 275 | 280 | 285 |
| caa aaa gca gca gaa gaa gca gca cga gtt cta gta gat cct gtt cca | | | 912 |
| Gln Lys Ala Ala Glu Glu Ala Ala Arg Val Leu Val Asp Pro Val Pro | | | |
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| Ser Tyr Lys Gln Val Lys Gln Leu Lys Tyr Val Gly Met Val Leu Asn | | | |
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| gaa gcg ctg cgc tta tgg cca act gct cct gcg ttt tcc cta tat gca | | | 1008 |
| Glu Ala Leu Arg Leu Trp Pro Thr Ala Pro Ala Phe Ser Leu Tyr Ala | | | |
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| aaa gaa gat acg gtg ctt gga gga gaa tat cct tta gaa aaa ggc gac | | | 1056 |
| Lys Glu Asp Thr Val Leu Gly Gly Glu Tyr Pro Leu Glu Lys Gly Asp | | | |
| | 340 | 345 | 350 |
| gaa cta atg gtt ctg att cct cag ctt cac cgt gat aaa aca att tgg | | | 1104 |
| Glu Leu Met Val Leu Ile Pro Gln Leu His Arg Asp Lys Thr Ile Trp | | | |
| | 355 | 360 | 365 |
| gga gac gat gtg gaa gag ttc cgt cca gag cgt ttt gaa aat cca agt | | | 1152 |
| Gly Asp Asp Val Glu Glu Phe Arg Pro Glu Arg Phe Glu Asn Pro Ser | | | |
| | 370 | 375 | 380 |
| gcg att ccg cag cat gcg ttt aaa ccg ttt gga aac ggt cag cgt gcg | | | 1200 |
| Ala Ile Pro Gln His Ala Phe Lys Pro Phe Gly Asn Gly Gln Arg Ala | | | |
| | 385 | 390 | 395 |
| tgt atc ggt cag cag ttc gct ctt cat gaa gca acg ctg gta ctt ggt | | | 1248 |

| | | | | | | | | | | | | | | | | | |
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| Cys 400 | Ile | Gly | Gln | Gln | Phe | Ala | Leu | His | Glu | Ala | Thr | Leu | Val | Leu | Gly | 415 | |
| atg | atg | cta | aaa | cac | ttt | gac | ttt | gaa | gat | cat | aca | aac | tac | gag | ctg | 1296 | |
| Met | Met | Leu | Lys | His | Phe | Asp | Phe | Glu | Asp | His | Thr | Asn | Tyr | Glu | Leu | | |
| | | | | 420 | | | | | 425 | | | | | 430 | | | |
| gat | att | aaa | gaa | act | tta | acg | tta | aaa | cct | gaa | ggc | ttt | gtg | gta | aaa | 1344 | |
| Asp | Ile | Lys | Glu | Thr | Leu | Thr | Leu | Lys | Pro | Glu | Gly | Phe | Val | Val | Lys | | |
| | | | 435 | | | | | 440 | | | | | 445 | | | | |
| gca | aaa | tcg | aaa | aaa | att | ccg | ctt | ggc | ggg | att | cct | tca | cct | agc | act | 1392 | |
| Ala | Lys | Ser | Lys | Lys | Ile | Pro | Leu | Gly | Gly | Ile | Pro | Ser | Pro | Ser | Thr | | |
| | | 450 | | | | | 455 | | | | 460 | | | | | | |
| gaa | cag | tct | gct | aaa | aaa | gta | cgc | aaa | aag | gca | gaa | aac | gct | cat | aat | 1440 | |
| Glu | Gln | Ser | Ala | Lys | Lys | Val | Arg | Lys | Lys | Ala | Glu | Asn | Ala | His | Asn | | |
| | 465 | | | | | 470 | | | | | 475 | | | | | | |
| acg | ccg | ctg | ctt | gtg | cta | tac | ggg | tca | aat | atg | gga | aca | gct | gaa | gga | 1488 | |
| Thr | Pro | Leu | Leu | Val | Leu | Tyr | Gly | Ser | Asn | Met | Gly | Thr | Ala | Glu | Gly | | |
| 480 | | | | 485 | | | | | 490 | | | | | 495 | | | |
| acg | gcg | cgt | gat | tta | gca | gat | att | gca | atg | agc | aaa | gga | ttt | gca | ccg | 1536 | |
| Thr | Ala | Arg | Asp | Leu | Ala | Asp | Ile | Ala | Met | Ser | Lys | Gly | Phe | Ala | Pro | | |
| | | | | 500 | | | | | 505 | | | | | 510 | | | |
| cag | gtc | gca | acg | ctt | gat | tca | cac | gcc | gga | aat | ctt | ccg | cgc | gaa | gga | 1584 | |
| Gln | Val | Ala | Thr | Leu | Asp | Ser | His | Ala | Gly | Asn | Leu | Pro | Arg | Glu | Gly | | |
| | | | 515 | | | | | 520 | | | | | 525 | | | | |
| gct | gta | tta | att | gta | acg | gcg | tct | tat | aac | ggg | cat | ccg | cct | gat | aac | 1632 | |
| Ala | Val | Leu | Ile | Val | Thr | Ala | Ser | Tyr | Asn | Gly | His | Pro | Pro | Asp | Asn | | |
| | | 530 | | | | | 535 | | | | | 540 | | | | | |
| gca | aag | caa | ttt | gtc | gac | tgg | tta | gac | caa | gcg | tct | gct | gat | gaa | gta | 1680 | |
| Ala | Lys | Gln | Phe | Val | Asp | Trp | Leu | Asp | Gln | Ala | Ser | Ala | Asp | Glu | Val | | |
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| aaa | ggc | gtt | cgc | tac | tcc | gta | ttt | gga | tgc | ggc | gat | aaa | aac | tgg | gct | 1728 | |
| Lys | Gly | Val | Arg | Tyr | Ser | Val | Phe | Gly | Cys | Gly | Asp | Lys | Asn | Trp | Ala | | |
| 560 | | | | 565 | | | | | 570 | | | | | 575 | | | |
| act | acg | tat | caa | aaa | gtg | cct | gct | ttt | atc | gat | gaa | acg | ctt | gcc | gct | 1776 | |
| Thr | Thr | Tyr | Gln | Lys | Val | Pro | Ala | Phe | Ile | Asp | Glu | Thr | Leu | Ala | Ala | | |
| | | | | 580 | | | | | 585 | | | | | 590 | | | |
| aaa | ggg | gca | gaa | aac | atc | gct | gac | cgc | ggg | gaa | gca | gat | gca | agc | gac | 1824 | |
| Lys | Gly | Ala | Glu | Asn | Ile | Ala | Asp | Arg | Gly | Glu | Ala | Asp | Ala | Ser | Asp | | |
| | | | 595 | | | | | 600 | | | | | 605 | | | | |
| gac | ttt | gaa | ggc | aca | tat | gaa | gaa | tgg | cgt | gaa | cat | atg | t | | | | |

| | | | | | | | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|--|
| Ala | Lys | Met | His | Gly | Ala | Phe | Ser | Thr | Asn | Val | Val | Ala | Ser | Lys | Glu | | |
| | | | | 660 | | | | | 665 | | | | | 670 | | | |
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| Leu | Gln | Gln | Pro | Gly | Ser | Ala | Arg | Ser | Thr | Arg | His | Leu | Glu | Ile | Glu | | |
| | | | 675 | | | | | 680 | | | | | 685 | | | | |
| ctt | cca | aaa | gaa | gct | tct | tat | caa | gaa | gga | gat | cat | tta | ggt | gtt | att | 2112 | |
| Leu | Pro | Lys | Glu | Ala | Ser | Tyr | Gln | Glu | Gly | Asp | His | Leu | Gly | Val | Ile | | |
| | | 690 | | | | | 695 | | | | | 700 | | | | | |
| cct | cgc | aac | tat | gaa | gga | ata | gta | aac | cgt | gta | aca | gca | agg | ttc | ggc | 2160 | |
| Pro | Arg | Asn | Tyr | Glu | Gly | Ile | Val | Asn | Arg | Val | Thr | Ala | Arg | Phe | Gly | | |
| | 705 | | | | | 710 | | | | | 715 | | | | | | |
| cta | gat | gca | tca | cag | caa | atc | cgt | ctg | gaa | gca | gaa | gaa | gaa | aaa | tta | 2208 | |
| Leu | Asp | Ala | Ser | Gln | Gln | Ile | Arg | Leu | Glu | Ala | Glu | Glu | Glu | Lys | Leu | | |
| | 720 | | | | 725 | | | | | 730 | | | | | 735 | | |
| gct | cat | ttg | cca | ctc | gct | aaa | aca | gta | tcc | gta | gaa | gag | ctt | ctg | caa | 2256 | |
| Ala | His | Leu | Pro | Leu | Ala | Lys | Thr | Val | Ser | Val | Glu | Glu | Leu | Leu | Gln | | |
| | | | 740 | | | | | | 745 | | | | | 750 | | | |
| tac | gtg | gag | ctt | caa | gat | cct | gtt | acg | cgc | acg | cag | ctt | cgc | gca | atg | 2304 | |
| Tyr | Val | Glu | Leu | Gln | Asp | Pro | Val | Thr | Arg | Thr | Gln | Leu | Arg | Ala | Met | | |
| | | 755 | | | | | | 760 | | | | | 765 | | | | |
| gct | gct | aaa | acg | gtc | tgc | ccg | ccg | cat | aaa | gta | gag | ctt | gaa | gcc | ttg | 2352 | |
| Ala | Ala | Lys | Thr | Val | Cys | Pro | Pro | His | Lys | Val | Glu | Leu | Glu | Ala | Leu | | |
| | | 770 | | | | | 775 | | | | | 780 | | | | | |
| ctt | gaa | aag | caa | gcc | tac | aaa | gaa | caa | gtg | ctg | gca | aaa | cgt | tta | aca | 2400 | |
| Leu | Glu | Lys | Gln | Ala | Tyr | Lys | Glu | Gln | Val | Leu | Ala | Lys | Arg | Leu | Thr | | |
| | 785 | | | | | 790 | | | | | 795 | | | | | | |
| atg | ctt | gaa | ctg | ctt | gaa | aaa | tac | ccg | gcg | tgt | gaa | atg | aaa | ttc | agc | 2448 | |
| Met | Leu | Glu | Leu | Leu | Glu | Lys | Tyr | Pro | Ala | Cys | Glu | Met | Lys | Phe | Ser | | |
| | 800 | | | | 805 | | | | | 810 | | | | | 815 | | |
| gaa | ttt | atc | gcc | ctt | ctg | cca | agc | ata | cgc | ccg | cgc | tat | tac | tcg | att | 2496 | |
| Glu | Phe | Ile | Ala | Leu | Leu | Pro | Ser | Ile | Arg | Pro | Arg | Tyr | Tyr | Ser | Ile | | |
| | | | 820 | | | | | | 825 | | | | | 830 | | | |
| tct | tca | tca | cct | cgt | gtc | gat | gaa | aaa | caa | gca | agc | atc | acg | gtc | agc | 2544 | |
| Ser | Ser | Ser | Pro | Arg | Val | Asp | Glu | Lys | Gln | Ala | Ser | Ile | Thr | Val | Ser | | |
| | | | 835 | | | | | 840 | | | | | 845 | | | | |
| gtt | gtc | tca | gga | gaa | gcg | tgg | agc | gga | tat | gga | gaa | tat | aaa | gga | att | 2592 | |
| Val | Val | Ser | Gly | Glu | Ala | Trp | Ser | Gly | Tyr | Gly | Glu | Tyr | Lys | Gly | Ile | | |
| | | 850 | | | | | 855 | | | | | 860 | | | | | |
| gcg | tcg | aac | tat | ctt | gcc | gag | ctg | caa | gaa | gga | gat | acg | att | acg | tgc | 2640 | |
| Ala | Ser | Asn | Tyr | Leu | Ala | Glu | Leu | Gln | Glu | Gly | Asp | Thr | Ile | Thr | Cys | | |
| | | 865 | | | | 870 | | | | | 875 | | | | | | |
| ttt | att | tcc | aca | ccg | cag | tca | gaa | ttt | acg | ctg | cca | aaa | gac | cct | gaa | 2688 | |
| Phe | Ile | Ser | Thr | Pro | Gln | Ser | Glu | Phe | Thr | Leu | Pro | Lys | Asp | Pro | Glu | | |
| | | | | 885 | | | | | 890 | | | | | | 895 | | |
| acg | ccg | ctt | atc | atg | gtc | gga | ccg | gga | aca | ggc | gtc | gcg | ccg | ttt | aga | 2736 | |
| Thr | Pro | Leu | Ile | Met | Val | Gly | Pro | Gly | Thr | Gly | Val | Ala | Pro | Phe | Arg | | |
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| | | | | | | | | | | | | | | | | | |
|------|------|-----|-----|------|------|------|------|-----|------|-----|------|------|-----|-----|-----|------|--|
| Gly | Phe | Val | Gln | Ala | Arg | Lys | Gln | Leu | Lys | Glu | Gln | Gly | Gln | Ser | Leu | | |
| | | | 915 | | | | | 920 | | | | | 925 | | | | |
| gga | gaa | gca | cat | tta | tac | ttc | ggc | tgc | cgt | tca | cct | cat | gaa | gac | tat | 2832 | |
| Gly | Glu | Ala | His | Leu | Tyr | Phe | Gly | Cys | Arg | Ser | Pro | His | Glu | Asp | Tyr | | |
| | | 930 | | | | | 935 | | | | | 940 | | | | | |
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| Leu | Tyr | Gln | Glu | Glu | Leu | Glu | Asn | Ala | Gln | Ser | Glu | Gly | Ile | Ile | Thr | | |
| | 945 | | | | | 950 | | | | | 955 | | | | | | |
| ctt | cat | acc | gct | ttt | tct | cgc | atg | cca | aat | cag | ccg | aaa | aca | tac | gtt | 2928 | |
| Leu | His | Thr | Ala | Phe | Ser | Arg | Met | Pro | Asn | Gln | Pro | Lys | Thr | Tyr | Val | | |
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| cag | cac | gta | atg | gaa | caa | gac | ggc | aag | aaa | ttg | att | gaa | ctt | ctt | gat | 2976 | |
| Gln | His | Val | Met | Glu | Gln | Asp | Gly | Lys | Lys | Leu | Ile | Glu | Leu | Leu | Asp | | |
| | | | 980 | | | | | 985 | | | | | 990 | | | | |
| caa | gga | gcg | cac | ttc | tat | att | tgc | gga | gac | gga | agc | caa | atg | gca | cct | 3024 | |
| Gln | Gly | Ala | His | Phe | Tyr | Ile | Cys | Gly | Asp | Gly | Ser | Gln | Met | Ala | Pro | | |
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| gcc | gtt | gaa | gca | acg | ctt | atg | aaa | agc | tat | gct | gac | gtt | cac | caa | gtg | 3072 | |
| Ala | Val | Glu | Ala | Thr | Leu | Met | Lys | Ser | Tyr | Ala | Asp | Val | His | Gln | Val | | |
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| Ser | Glu | Ala | Asp | Ala | Arg | Leu | Trp | Leu | Gln | Gln | Leu | Glu | Glu | Lys | Gly | | |
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<213> Bacillus megaterium

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| Thr | Ile | Lys | Glu | Met | Pro | Gln | Pro | Lys | Thr | Phe | Gly | Glu | Leu | Lys | Asn | | |
| 1 | | | | 5 | | | | | 10 | | | | | 15 | | | |
| Leu | Pro | Leu | Leu | Asn | Thr | Asp | Lys | Pro | Val | Gln | Ala | Leu | Met | Lys | Ile | | |
| | | 20 | | | | | 25 | | | | | | 30 | | | | |
| Ala | Asp | Glu | Leu | Gly | Glu | Ile | Phe | Lys | Phe | Glu | Ala | Pro | Gly | Arg | Val | | |
| | 35 | | | | | 40 | | | | | | 45 | | | | | |
| Thr | Arg | Tyr | Leu | Ser | Ser | Gln | Arg | Leu | Ile | Lys | Glu | Ala | Cys | Asp | Glu | | |
| | 50 | | | | | 55 | | | | | 60 | | | | | | |
| Ser | Arg | Phe | Asp | Lys | Asn | Leu | Ser | Gln | Ala | Leu | Lys | Phe | Val | Arg | Asp | | |
| 65 | | | | | 70 | | | | 75 | | | | | 80 | | | |
| Phe | Ala | Gly | Asp | Gly | Leu | Phe | Thr | Ser | Trp | Thr | His | Glu | Lys | Asn | Trp | | |
| | | 85 | | | | | | 90 | | | | | | 95 | | | |
| Lys | Lys | Ala | His | Asn | Ile | Leu | Leu | Pro | Ser | Phe | Ser | Gln | Gln | Ala | Met | | |
| | | 100 | | | | | | 105 | | | | | 110 | | | | |
| Lys | Gly | Tyr | His | Ala | Met | Met | Val | Asp | Ile | Ala | Val | Gln | Leu | Val | Gln | | |

| 115 | | | | | 120 | | | | | 125 | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Lys | Trp | Glu | Arg | Leu | Asn | Ala | Asp | Glu | His | Ile | Glu | Val | Pro | Glu | Asp |
| 130 | | | | | | 135 | | | | | 140 | | | | |
| Met | Thr | Arg | Leu | Thr | Leu | Asp | Thr | Ile | Gly | Leu | Cys | Gly | Phe | Asn | Tyr |
| 145 | | | | | 150 | | | | | 155 | | | | | 160 |
| Arg | Phe | Asn | Ser | Phe | Tyr | Arg | Asp | Gln | Pro | His | Pro | Phe | Ile | Thr | Ser |
| | | | | 165 | | | | | 170 | | | | | 175 | |
| Met | Val | Arg | Ala | Leu | Asp | Glu | Ala | Met | Asn | Lys | Leu | Gln | Arg | Ala | Asn |
| | | | 180 | | | | | | 185 | | | | | 190 | |
| Pro | Asp | Asp | Pro | Ala | Tyr | Asp | Glu | Asn | Lys | Arg | Gln | Phe | Gln | Glu | Asp |
| | | 195 | | | | | 200 | | | | | 205 | | | |
| Ile | Lys | Val | Met | Asn | Asp | Leu | Val | Asp | Lys | Ile | Ile | Ala | Asp | Arg | Lys |
| 210 | | | | | | 215 | | | | | 220 | | | | |
| Ala | Ser | Gly | Glu | Gln | Ser | Asp | Asp | Leu | Leu | Thr | His | Met | Leu | Asn | Gly |
| 225 | | | | | 230 | | | | | 235 | | | | | 240 |
| Lys | Asp | Pro | Glu | Thr | Gly | Glu | Pro | Leu | Asp | Asp | Glu | Asn | Ile | Arg | Tyr |
| | | | | 245 | | | | | 250 | | | | | 255 | |
| Gln | Ile | Ile | Thr | Phe | Leu | Ile | Ala | Gly | His | Glu | Thr | Thr | Ser | Gly | Leu |
| | | | 260 | | | | | 265 | | | | | 270 | | |
| Leu | Ser | Phe | Ala | Leu | Tyr | Phe | Leu | Val | Lys | Asn | Pro | His | Val | Leu | Gln |
| | | 275 | | | | | 280 | | | | | 285 | | | |
| Lys | Ala | Ala | Glu | Glu | Ala | Ala | Arg | Val | Leu | Val | Asp | Pro | Val | Pro | Ser |
| | 290 | | | | | 295 | | | | | 300 | | | | |
| Tyr | Lys | Gln | Val | Lys | Gln | Leu | Lys | Tyr | Val | Gly | Met | Val | Leu | Asn | Glu |
| 305 | | | | | 310 | | | | | 315 | | | | | 320 |
| Ala | Leu | Arg | Leu | Trp | Pro | Thr | Ala | Pro | Ala | Phe | Ser | Leu | Tyr | Ala | Lys |
| | | | | 325 | | | | | 330 | | | | | 335 | |
| Glu | Asp | Thr | Val | Leu | Gly | Gly | Glu | Tyr | Pro | Leu | Glu | Lys | Gly | Asp | Glu |
| | | | 340 | | | | | 345 | | | | | 350 | | |
| Leu | Met | Val | Leu | Ile | Pro | Gln | Leu | His | Arg | Asp | Lys | Thr | Ile | Trp | Gly |
| | 355 | | | | | | 360 | | | | | 365 | | | |
| Asp | Asp | Val | Glu | Glu | Phe | Arg | Pro | Glu | Arg | Phe | Glu | Asn | Pro | Ser | Ala |
| | 370 | | | | | 375 | | | | | 380 | | | | |
| Ile | Pro | Gln | His | Ala | Phe | Lys | Pro | Phe | Gly | Asn | Gly | Gln | Arg | Ala | Cys |
| 385 | | | | | 390 | | | | | 395 | | | | | 400 |
| Ile | Gly | Gln | Gln | Phe | Ala | Leu | His | Glu | Ala | Thr | Leu | Val | Leu | Gly | Met |
| | | | | 405 | | | | | 410 | | | | | 415 | |
| Met | Leu | Lys | His | Phe | Asp | Phe | Glu | Asp | His | Thr | Asn | Tyr | Glu | Leu | Asp |
| | | | 420 | | | | | 425 | | | | | 430 | | |
| Ile | Lys | Glu | Thr | Leu | Thr | Leu | Lys | Pro | Glu | Gly | Phe | Val | Val | Lys | Ala |
| | 435 | | | | | | 440 | | | | | 445 | | | |
| Lys | Ser | Lys | Lys | Ile | Pro | Leu | Gly | Gly | Ile | Pro | Ser | Pro | Ser | Thr | Glu |
| | 450 | | | | | 455 | | | | | 460 | | | | |

Gln Ser Ala Lys Lys Val Arg Lys Lys Ala Glu Asn Ala His Asn Thr
 465 470 475 480
 Pro Leu Leu Val Leu Tyr Gly Ser Asn Met Gly Thr Ala Glu Gly Thr
 485 490 495
 Ala Arg Asp Leu Ala Asp Ile Ala Met Ser Lys Gly Phe Ala Pro Gln
 500 505 510
 Val Ala Thr Leu Asp Ser His Ala Gly Asn Leu Pro Arg Glu Gly Ala
 515 520 525
 Val Leu Ile Val Thr Ala Ser Tyr Asn Gly His Pro Pro Asp Asn Ala
 530 535 540
 Lys Gln Phe Val Asp Trp Leu Asp Gln Ala Ser Ala Asp Glu Val Lys
 545 550 555 560
 Gly Val Arg Tyr Ser Val Phe Gly Cys Gly Asp Lys Asn Trp Ala Thr
 565 570 575
 Thr Tyr Gln Lys Val Pro Ala Phe Ile Asp Glu Thr Leu Ala Ala Lys
 580 585 590
 Gly Ala Glu Asn Ile Ala Asp Arg Gly Glu Ala Asp Ala Ser Asp Asp
 595 600 605
 Phe Glu Gly Thr Tyr Glu Glu Trp Arg Glu His Met Trp Ser Asp Val
 610 615 620
 Ala Ala Tyr Phe Asn Leu Asp Ile Glu Asn Ser Glu Asp Asn Lys Ser
 625 630 635 640
 Thr Leu Ser Leu Gln Phe Val Asp Ser Ala Ala Asp Met Pro Leu Ala
 645 650 655
 Lys Met His Gly Ala Phe Ser Thr Asn Val Val Ala Ser Lys Glu Leu
 660 665 670
 Gln Gln Pro Gly Ser Ala Arg Ser Thr Arg His Leu Glu Ile Glu Leu
 675 680 685
 Pro Lys Glu Ala Ser Tyr Gln Glu Gly Asp His Leu Gly Val Ile Pro
 690 695 700
 Arg Asn Tyr Glu Gly Ile Val Asn Arg Val Thr Ala Arg Phe Gly Leu
 705 710 715 720
 Asp Ala Ser Gln Gln Ile Arg Leu Glu Ala Glu Glu Glu Lys Leu Ala
 725 730 735
 His Leu Pro Leu Ala Lys Thr Val Ser Val Glu Glu Leu Leu Gln Tyr
 740 745 750
 Val Glu Leu Gln Asp Pro Val Thr Arg Thr Gln Leu Arg Ala Met Ala
 755 760 765
 Ala Lys Thr Val Cys Pro Pro His Lys Val Glu Leu Glu Ala Leu Leu
 770 775 780
 Glu Lys Gln Ala Tyr Lys Glu Gln Val Leu Ala Lys Arg Leu Thr Met
 785 790 795 800
 Leu Glu Leu Leu Glu Lys Tyr Pro Ala Cys Glu Met Lys Phe Ser Glu

| 805 | 810 | 815 |
|---|---------------------------------|------|
| Phe Ile Ala Leu Leu Pro Ser Ile | Arg Pro Arg Tyr Tyr Ser Ile Ser | |
| 820 | 825 | 830 |
| Ser Ser Pro Arg Val Asp Glu Lys Gln Ala Ser Ile Thr Val Ser Val | | |
| 835 | 840 | 845 |
| Val Ser Gly Glu Ala Trp Ser Gly Tyr Gly Glu Tyr Lys Gly Ile Ala | | |
| 850 | 855 | 860 |
| Ser Asn Tyr Leu Ala Glu Leu Gln Glu Gly Asp Thr Ile Thr Cys Phe | | |
| 865 | 870 | 875 |
| Ile Ser Thr Pro Gln Ser Glu Phe Thr Leu Pro Lys Asp Pro Glu Thr | | |
| 885 | 890 | 895 |
| Pro Leu Ile Met Val Gly Pro Gly Thr Gly Val Ala Pro Phe Arg Gly | | |
| 900 | 905 | 910 |
| Phe Val Gln Ala Arg Lys Gln Leu Lys Glu Gln Gly Gln Ser Leu Gly | | |
| 915 | 920 | 925 |
| Glu Ala His Leu Tyr Phe Gly Cys Arg Ser Pro His Glu Asp Tyr Leu | | |
| 930 | 935 | 940 |
| Tyr Gln Glu Glu Leu Glu Asn Ala Gln Ser Glu Gly Ile Ile Thr Leu | | |
| 945 | 950 | 955 |
| His Thr Ala Phe Ser Arg Met Pro Asn Gln Pro Lys Thr Tyr Val Gln | | |
| 965 | 970 | 975 |
| His Val Met Glu Gln Asp Gly Lys Lys Leu Ile Glu Leu Leu Asp Gln | | |
| 980 | 985 | 990 |
| Gly Ala His Phe Tyr Ile Cys Gly Asp Gly Ser Gln Met Ala Pro Ala | | |
| 995 | 1000 | 1005 |
| Val Glu Ala Thr Leu Met Lys Ser Tyr Ala Asp Val His Gln Val Ser | | |
| 1010 | 1015 | 1020 |
| Glu Ala Asp Ala Arg Leu Trp Leu Gln Gln Leu Glu Glu Lys Gly Arg | | |
| 1025 | 1030 | 1035 |
| Tyr Ala Lys Asp Val Trp Ala Gly | | |
| 1045 | | |

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<211> 30

<212> DNA

<213> Artificial sequence

<220>

<223> Description of the artificial sequence: PCR primer

<400> 3

gcaggagacg gggtgnnnac aagctggacg

30

<210> 4

<211> 30

<212> DNA

<213> Artificial sequence

<220>

<223> Description of the artificial sequence: PCR primer

<400> 4

cgtccagctt gtnnncaacc cgtctcctgc

30

<210> 5

<211> 34

<212> DNA

<213> Artificial sequence

<220>

<223> Description of the artificial sequence: PCR primer

<400> 5

gaagcaatga acaagnnnca gcgagcaaatt ccag

34

<210> 6

<211> 34

<212> DNA

<213> Artificial sequence

<220>

<223> Description of the artificial sequence: PCR primer

<400> 6

ctggatttgc tcgctgnnnc ttgttcattg cttc

34

<210> 7

<211> 41

<212> DNA

<213> Artificial sequence

<220>

<223> Description of the artificial sequence: PCR primer

<400> 7

gctttgataa aaacttaaag tcaannnctt aaatttgtac g

41

<210> 8

<211> 40

<212> DNA

<213> Artificial sequence

<220>

<223> Description of the artificial sequence: PCR primer

<400> 8

cgtacaaatt taagnnnttg acttaagttt ttatcaaagc

40

<210> 9

<211> 37

<212> DNA

<213> Artificial sequence

<220>

<223> Description of the artificial sequence: PCR primer

<400> 9

gttatttaa acagataaan nngttcaagc ttgatg

37

<210> 10

<211> 37

<212> DNA

<213> Artificial sequence

<220>

<223> Description of the artificial sequence: PCR primer

<400> 10

catcaaagct tgaacnnntt tatctgtggt taataac

37

<210> 11

<211> 37

<212> DNA

<213> Artificial sequence

<220>

<223> Description of the artificial sequence: PCR primer

<400> 11

gttatttaa acagataaac cgnnncaagc ttgatg

37

<210> 12

<211> 37

<212> DNA

<213> Artificial sequence

<220>

<223> Description of the artificial sequence: PCR primer

<400> 12

catcaaagct tgnnncggtt tatctgtggt taataac

37

<210> 13

<211> 33

<212> DNA

<213> Artificial sequence

<220>

<223> Description of the artificial sequence: PCR primer

<400> 13

cgaggcgctt ggtnnnngtaa cgcgtactt atc

33

<210> 14

<211> 33

<212> DNA

<213> Artificial sequence

<220>

<223> Description of the artificial sequence: PCR-primer

<400> 14

gataagtagc gcgttacnnn accaggcgcc tcg

33

<210> 15

<211> 34
<212> DNA
<213> Artificial sequence

<220>
<223> Description of the artificial sequence: PCR primer

<400> 15
cctggtcgtg taacgcgcnn nttatcaagt cagc 34

<210> 16
<211> 34
<212> DNA
<213> Artificial sequence

<220>
<223> Description of the artificial sequence: PCR primer

<400> 16
gctgacttga taannngcgc gttacacgac cagg 34

<210> 17
<211> 40
<212> DNA
<213> Artificial sequence

<220>
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<400> 17
gctttgataa aaacttannn caagcgctta aatttgtacg 40

<210> 18
<211> 40
<212> DNA
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<220>
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<400> 18
cgtacaaatt taagcgcttg nnntaagttt ttatcaaagc 40

<210> 19
<211> 30
<212> DNA
<213> Artificial sequence

<220>
<223> Description of the artificial sequence: PCR primer

<400> 19
ggcgacgaac tannngttct gattcctcag 30

<210> 20
<211> 30
<212> DNA
<213> Artificial sequence

<220>

<223> Description of the artificial sequence: PCR primer

<400> 20

ctgaggaatc agaacnnnta gttcgtcgcc

30

SEQUENCE LISTING

<110> Hauer, Bernhard
 Pleiss, Jurgen
 Schwaneberg, Ulrich
 Schmitt, Jutta

<120> Modified cytochrome P450 monooxygenases

<130> M/40434

<140> US 10/031,695

<150> PCT/EP00/07252

<151> 2000-07-27

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| atg | aca | att | aaa | gaa | atg | cct | cag | cca | aaa | acg | ttt | gga | gag | ctt | aaa | 48 |
| Thr | Ile | Lys | Glu | Met | Pro | Gln | Pro | Lys | Thr | Phe | Gly | Glu | Leu | Lys | | |
| 1 | | | | 5 | | | | | 10 | | | | | 15 | | |
| aat | tta | ccg | tta | tta | aac | aca | gat | aaa | ccg | gtt | caa | gct | ttg | atg | aaa | 96 |
| Asn | Leu | Pro | Leu | Leu | Asn | Thr | Asp | Lys | Pro | Val | Gln | Ala | Leu | Met | Lys | |
| | | | 20 | | | | | 25 | | | | | | 30 | | |
| att | gcg | gat | gaa | tta | gga | gaa | atc | ttt | aaa | ttc | gag | gcg | cct | ggt | cgt | 144 |
| Ile | Ala | Asp | Glu | Leu | Gly | Glu | Ile | Phe | Lys | Phe | Glu | Ala | Pro | Gly | Arg | |
| | | | 35 | | | | 40 | | | | | | 45 | | | |
| gta | acg | cgc | tac | tta | tca | agt | cag | cgt | cta | att | aaa | gaa | gca | tgc | gat | 192 |
| Val | Thr | Arg | Tyr | Leu | Ser | Ser | Gln | Arg | Leu | Ile | Lys | Glu | Ala | Cys | Asp | |
| | | 50 | | | | | 55 | | | | | 60 | | | | |
| gaa | tca | cgc | ttt | gat | aaa | aac | tta | agt | caa | gcg | ctt | aaa | ttt | gta | cgt | 240 |
| Glu | Ser | Arg | Phe | Asp | Lys | Asn | Leu | Ser | Gln | Ala | Leu | Lys | Phe | Val | Arg | |
| | 65 | | | | | 70 | | | | | 75 | | | | | |
| gat | ttt | gca | gga | gac | ggg | tta | ttt | aca | agc | tgg | acg | cat | gaa | aaa | aat | 288 |
| Asp | Phe | Ala | Gly | Asp | Gly | Leu | Phe | Thr | Ser | Trp | Thr | His | Glu | Lys | Asn | |
| | 80 | | | | 85 | | | | 90 | | | | | | 95 | |
| tgg | aaa | aaa | gcg | cat | aat | atc | tta | ctt | cca | agc | ttc | agt | cag | cag | gca | 336 |
| Trp | Lys | Lys | Ala | His | Asn | Ile | Leu | Leu | Pro | Ser | Phe | Ser | Gln | Gln | Ala | |
| | | | 100 | | | | | | 105 | | | | | | 110 | |

| | |
|---|------|
| atg aaa ggc tat cat gcg atg atg gtc gat atc gcc gtg cag ctt gtt | 384 |
| Met Lys Gly Tyr His Ala Met Met Val Asp Ile Ala Val Gln Leu Val | |
| 115 120 125 | |
| caa aag tgg gag cgt cta aat gca gat gag cat att gaa gta ccg gaa | 432 |
| Gln Lys Trp Glu Arg Leu Asn Ala Asp Glu His Ile Glu Val Pro Glu | |
| 130 135 140 | |
| gac atg aca cgt tta acg ctt gat aca att ggt ctt tgc ggc ttt aac | 480 |
| Asp Met Thr Arg Leu Thr Leu Asp Thr Ile Gly Leu Cys Gly Phe Asn | |
| 145 150 155 | |
| tat cgc ttt aac agc ttt tac cga gat cag cct cat cca ttt att aca | 528 |
| Tyr Arg Phe Asn Ser Phe Tyr Arg Asp Gln Pro His Pro Phe Ile Thr | |
| 160 165 170 175 | |
| agt atg gtc cgt gca ctg gat gaa gca atg aac aag ctg cag cga gca | 576 |
| Ser Met Val Arg Ala Leu Asp Glu Ala Met Asn Lys Leu Gln Arg Ala | |
| 180 185 190 | |
| aat cca gac gac cca gct tat gat gaa aac aag cgc cag ttt caa gaa | 624 |
| Asn Pro Asp Asp Pro Ala Tyr Asp Glu Asn Lys Arg Gln Phe Gln Glu | |
| 195 200 205 | |
| gat atc aag gtg atg aac gac cta gta gat aaa att att gca gat cgc | 672 |
| Asp Ile Lys Val Met Asn Asp Leu Val Asp Lys Ile Ile Ala Asp Arg | |
| 210 215 220 | |
| aaa gca agc ggt gaa caa agc gat gat tta tta acg cat atg cta aac | 720 |
| Lys Ala Ser Gly Glu Gln Ser Asp Asp Leu Leu Thr His Met Leu Asn | |
| 225 230 235 | |
| gga aaa gat cca gaa acg ggt gag ccg ctt gat gac gag aac att cgc | 768 |
| Gly Lys Asp Pro Glu Thr Gly Glu Pro Leu Asp Asp Glu Asn Ile Arg | |
| 240 245 250 255 | |
| tat caa att att aca ttc tta att gcg gga cac gaa aca aca agt ggt | 816 |
| Tyr Gln Ile Ile Thr Phe Leu Ile Ala Gly His Glu Thr Thr Ser Gly | |
| 260 265 270 | |
| ctt tta tca ttt gcg ctg tat ttc tta gtg aaa aat cca cat gta tta | 864 |
| Leu Leu Ser Phe Ala Leu Tyr Phe Leu Val Lys Asn Pro His Val Leu | |
| 275 280 285 | |
| caa aaa gca gca gaa gaa gca gca cga gtt cta gta gat cct gtt cca | 912 |
| Gln Lys Ala Ala Glu Glu Ala Ala Arg Val Leu Val Asp Pro Val Pro | |
| 290 295 300 | |
| agc tac aaa caa gtc aaa cag ctt aaa tat gtc ggc atg gtc tta aac | 960 |
| Ser Tyr Lys Gln Val Lys Gln Leu Lys Tyr Val Gly Met Val Leu Asn | |
| 305 310 315 | |
| gaa gcg ctg cgc tta tgg cca act gct cct gcg ttt tcc cta tat gca | 1008 |
| Glu Ala Leu Arg Leu Trp Pro Thr Ala Pro Ala Phe Ser Leu Tyr Ala | |
| 320 325 330 335 | |
| aaa gaa gat acg gtg ctt gga gga gaa tat cct tta gaa aaa ggc gac | 1056 |
| Lys Glu Asp Thr Val Leu Gly Gly Glu Tyr Pro Leu Glu Lys Gly Asp | |
| 340 345 350 | |

| | |
|---|------|
| gaa cta atg gtt ctg att cct cag ctt cac cgt gat aaa aca att tgg | 1104 |
| Glu Leu Met Val Leu Ile Pro Gln Leu His Arg Asp Lys Thr Ile Trp | |
| 355 360 365 | |
| gga gac gat gtg gaa gag ttc cgt cca gag cgt ttt gaa aat cca agt | 1152 |
| Gly Asp Asp Val Glu Glu Phe Arg Pro Glu Arg Phe Glu Asn Pro Ser | |
| 370 375 380 | |
| gcg att ccg cag cat gcg ttt aaa ccg ttt gga aac ggt cag cgt gcg | 1200 |
| Ala Ile Pro Gln His Ala Phe Lys Pro Phe Gly Asn Gly Gln Arg Ala | |
| 385 390 395 | |
| tgt atc ggt cag cag ttc gct ctt cat gaa gca acg ctg gta ctt ggt | 1248 |
| Cys Ile Gly Gln Gln Phe Ala Leu His Glu Ala Thr Leu Val Leu Gly | |
| 400 405 410 415 | |
| atg atg cta aaa cac ttt gac ttt gaa gat cat aca aac tac gag ctg | 1296 |
| Met Met Leu Lys His Phe Asp Phe Glu Asp His Thr Asn Tyr Glu Leu | |
| 420 425 430 | |
| gat att aaa gaa act tta acg tta aaa cct gaa ggc ttt gtg gta aaa | 1344 |
| Asp Ile Lys Glu Thr Leu Thr Leu Lys Pro Glu Gly Phe Val Val Lys | |
| 435 440 445 | |
| gca aaa tcg aaa aaa att ccg ctt ggc ggt att cct tca cct agc act | 1392 |
| Ala Lys Ser Lys Lys Ile Pro Leu Gly Gly Ile Pro Ser Pro Ser Thr | |
| 450 455 460 | |
| gaa cag tct gct aaa aaa gta cgc aaa aag gca gaa aac gct cat aat | 1440 |
| Glu Gln Ser Ala Lys Lys Val Arg Lys Lys Ala Glu Asn Ala His Asn | |
| 465 470 475 | |
| acg ccg ctg ctt gtg cta tac ggt tca aat atg gga aca gct gaa gga | 1488 |
| Thr Pro Leu Leu Val Leu Tyr Gly Ser Asn Met Gly Thr Ala Glu Gly | |
| 480 485 490 495 | |
| acg gcg cgt gat tta gca gat att gca atg agc aaa gga ttt gca ccg | 1536 |
| Thr Ala Arg Asp Leu Ala Asp Ile Ala Met Ser Lys Gly Phe Ala Pro | |
| 500 505 510 | |
| cag gtc gca acg ctt gat tca cac gcc gga aat ctt ccg cgc gaa gga | 1584 |
| Gln Val Ala Thr Leu Asp Ser His Ala Gly Asn Leu Pro Arg Glu Gly | |
| 515 520 525 | |
| gct gta tta att gta acg gcg tct tat aac ggt cat ccg cct gat aac | 1632 |
| Ala Val Leu Ile Val Thr Ala Ser Tyr Asn Gly His Pro Pro Asp Asn | |
| 530 535 540 | |
| gca aag caa ttt gtc gac tgg tta gac caa gcg tct gct gat gaa gta | 1680 |
| Ala Lys Gln Phe Val Asp Trp Leu Asp Gln Ala Ser Ala Asp Glu Val | |
| 545 550 555 | |
| aaa ggc gtt cgc tac tcc gta ttt gga tgc ggc gat aaa aac tgg gct | 1728 |
| Lys Gly Val Arg Tyr Ser Val Phe Gly Cys Gly Asp Lys Asn Trp Ala | |
| 560 565 570 575 | |
| act acg tat caa aaa gtg cct gct ttt atc gat gaa acg ctt gcc gct | 1776 |
| Thr Thr Tyr Gln Lys Val Pro Ala Phe Ile Asp Glu Thr Leu Ala Ala | |
| 580 585 590 | |

| | |
|---|------|
| aaa ggg gca gaa aac atc gct gac cgc ggt gaa gca gat gca agc gac | 1824 |
| Lys Gly Ala Glu Asn Ile Ala Asp Arg Gly Glu Ala Asp Ala Ser Asp | |
| 595 600 605 | |
| gac ttt gaa ggc aca tat gaa gaa tgg cgt gaa cat atg tgg agt gac | 1872 |
| Asp Phe Glu Gly Thr Tyr Glu Glu Trp Arg Glu His Met Trp Ser Asp | |
| 610 615 620 | |
| gta gca gcc tac ttt aac ctc gac att gaa aac agt gaa gat aat aaa | 1920 |
| Val Ala Ala Tyr Phe Asn Leu Asp Ile Glu Asn Ser Glu Asp Asn Lys | |
| 625 630 635 | |
| tct act ctt tca ctt caa ttt gtc gac agc gcc gcg gat atg ccg ctt | 1968 |
| Ser Thr Leu Ser Leu Gln Phe Val Asp Ser Ala Ala Asp Met Pro Leu | |
| 640 645 650 655 | |
| gcg aaa atg cac ggt gcg ttt tca acg aac gtc gta gca agc aaa gaa | 2016 |
| Ala Lys Met His Gly Ala Phe Ser Thr Asn Val Val Ala Ser Lys Glu | |
| 660 665 670 | |
| ctt caa cag cca ggc agt gca cga agc acg cga cat ctt gaa att gaa | 2064 |
| Leu Gln Gln Pro Gly Ser Ala Arg Ser Thr Arg His Leu Glu Ile Glu | |
| 675 680 685 | |
| ctt cca aaa gaa gct tct tat caa gaa gga gat cat tta ggt gtt att | 2112 |
| Leu Pro Lys Glu Ala Ser Tyr Gln Glu Gly Asp His Leu Gly Val Ile | |
| 690 695 700 | |
| cct cgc aac tat gaa gga ata gta aac cgt gta aca gca agg ttc ggc | 2160 |
| Pro Arg Asn Tyr Glu Gly Ile Val Asn Arg Val Thr Ala Arg Phe Gly | |
| 705 710 715 | |
| cta gat gca tca cag caa atc cgt ctg gaa gca gaa gaa gaa aaa tta | 2208 |
| Leu Asp Ala Ser Gln Gln Ile Arg Leu Glu Ala Glu Glu Glu Lys Leu | |
| 720 725 730 735 | |
| gct cat ttg cca ctc gct aaa aca gta tcc gta gaa gag ctt ctg caa | 2256 |
| Ala His Leu Pro Leu Ala Lys Thr Val Ser Val Glu Glu Leu Leu Gln | |
| 740 745 750 | |
| tac gtg gag ctt caa gat cct gtt acg cgc acg cag ctt cgc gca atg | 2304 |
| Tyr Val Glu Leu Gln Asp Pro Val Thr Arg Thr Gln Leu Arg Ala Met | |
| 755 760 765 | |
| gct gct aaa acg gtc tgc ccg ccg cat aaa gta gag ctt gaa gcc ttg | 2352 |
| Ala Ala Lys Thr Val Cys Pro Pro His Lys Val Glu Leu Glu Ala Leu | |
| 770 775 780 | |
| ctt gaa aag caa gcc tac aaa gaa caa gtg ctg gca aaa cgt tta aca | 2400 |
| Leu Glu Lys Gln Ala Tyr Lys Glu Gln Val Leu Ala Lys Arg Leu Thr | |
| 785 790 795 | |
| atg ctt gaa ctg ctt gaa aaa tac ccg gcg tgt gaa atg aaa ttc agc | 2448 |
| Met Leu Glu Leu Leu Glu Lys Tyr Pro Ala Cys Glu Met Lys Phe Ser | |
| 800 805 810 815 | |
| gaa ttt atc gcc ctt ctg cca agc ata cgc ccg cgc tat tac tcg att | 2496 |
| Glu Phe Ile Ala Leu Leu Pro Ser Ile Arg Pro Arg Tyr Tyr Ser Ile | |
| 820 825 830 | |

| | |
|---|------|
| tct tca tca cct cgt gtc gat gaa aaa caa gca agc atc acg gtc agc | 2544 |
| Ser Ser Ser Pro Arg Val Asp Glu Lys Gln Ala Ser Ile Thr Val Ser | |
| 835 840 845 | |
| gtt gtc tca gga gaa gcg tgg agc gga tat gga gaa tat aaa gga att | 2592 |
| Val Val Ser Gly Glu Ala Trp Ser Gly Tyr Gly Glu Tyr Lys Gly Ile | |
| 850 855 860 | |
| gcg tcg aac tat ctt gcc gag ctg caa gaa gga gat acg att acg tgc | 2640 |
| Ala Ser Asn Tyr Leu Ala Glu Leu Gln Glu Gly Asp Thr Ile Thr Cys | |
| 865 870 875 | |
| ttt att tcc aca ccg cag tca gaa ttt acg ctg cca aaa gac cct gaa | 2688 |
| Phe Ile Ser Thr Pro Gln Ser Glu Phe Thr Leu Pro Lys Asp Pro Glu | |
| 880 885 890 895 | |
| acg ccg ctt atc atg gtc gga ccg gga aca ggc gtc gcg ccg ttt aga | 2736 |
| Thr Pro Leu Ile Met Val Gly Pro Gly Thr Gly Val Ala Pro Phe Arg | |
| 900 905 910 | |
| ggc ttt gtg cag gcg cgc aaa cag cta aaa gaa caa gga cag tca ctt | 2784 |
| Gly Phe Val Gln Ala Arg Lys Gln Leu Lys Glu Gln Gly Gln Ser Leu | |
| 915 920 925 | |
| gga gaa gca cat tta tac ttc ggc tgc cgt tca cct cat gaa gac tat | 2832 |
| Gly Glu Ala His Leu Tyr Phe Gly Cys Arg Ser Pro His Glu Asp Tyr | |
| 930 935 940 | |
| ctg tat caa gaa gag ctt gaa aac gcc caa agc gaa ggc atc att acg | 2880 |
| Leu Tyr Gln Glu Glu Leu Glu Asn Ala Gln Ser Glu Gly Ile Ile Thr | |
| 945 950 955 | |
| ctt cat acc gct ttt tct cgc atg cca aat cag ccg aaa aca tac gtt | 2928 |
| Leu His Thr Ala Phe Ser Arg Met Pro Asn Gln Pro Lys Thr Tyr Val | |
| 960 965 970 975 | |
| cag cac gta atg gaa caa gac ggc aag aaa ttg att gaa ctt ctt gat | 2976 |
| Gln His Val Met Glu Gln Asp Gly Lys Lys Leu Ile Glu Leu Leu Asp | |
| 980 985 990 | |
| caa gga gcg cac ttc tat att tgc gga gac gga agc caa atg gca cct | 3024 |
| Gln Gly Ala His Phe Tyr Ile Cys Gly Asp Gly Ser Gln Met Ala Pro | |
| 995 1000 1005 | |
| gcc gtt gaa gca acg ctt atg aaa agc tat gct gac gtt cac caa gtg | 3072 |
| Ala Val Glu Ala Thr Leu Met Lys Ser Tyr Ala Asp Val His Gln Val | |
| 1010 1015 1020 | |
| agt gaa gca gac gct cgc tta tgg ctg cag cag cta gaa gaa aaa ggc | 3120 |
| Ser Glu Ala Asp Ala Arg Leu Trp Leu Gln Gln Leu Glu Glu Lys Gly | |
| 1025 1030 1035 | |
| cga tac gca aaa gac gtg tgg gct ggg taa | 3150 |
| Arg Tyr Ala Lys Asp Val Trp Ala Gly | |
| 1040 1045 | |

<210> 2

<211> 1048

<212> PRT

<213> Bacillus megaterium

<400> 2

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Thr Ile Lys Glu Met Pro Gln Pro Lys Thr Phe Gly Glu Leu Lys Asn
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Leu Pro Leu Leu Asn Thr Asp Lys Pro Val Gln Ala Leu Met Lys Ile
      20           25           30

Ala Asp Glu Leu Gly Glu Ile Phe Lys Phe Glu Ala Pro Gly Arg Val
 35           40           45

Thr Arg Tyr Leu Ser Ser Gln Arg Leu Ile Lys Glu Ala Cys Asp Glu
 50           55           60

Ser Arg Phe Asp Lys Asn Leu Ser Gln Ala Leu Lys Phe Val Arg Asp
 65           70           75           80

Phe Ala Gly Asp Gly Leu Phe Thr Ser Trp Thr His Glu Lys Asn Trp
      85           90           95

Lys Lys Ala His Asn Ile Leu Leu Pro Ser Phe Ser Gln Gln Ala Met
      100           105           110

Lys Gly Tyr His Ala Met Met Val Asp Ile Ala Val Gln Leu Val Gln
 115           120           125

Lys Trp Glu Arg Leu Asn Ala Asp Glu His Ile Glu Val Pro Glu Asp
 130           135           140

Met Thr Arg Leu Thr Leu Asp Thr Ile Gly Leu Cys Gly Phe Asn Tyr
 145           150           155           160

Arg Phe Asn Ser Phe Tyr Arg Asp Gln Pro His Pro Phe Ile Thr Ser
      165           170           175

Met Val Arg Ala Leu Asp Glu Ala Met Asn Lys Leu Gln Arg Ala Asn
 180           185           190

Pro Asp Asp Pro Ala Tyr Asp Glu Asn Lys Arg Gln Phe Gln Glu Asp
 195           200           205

Ile Lys Val Met Asn Asp Leu Val Asp Lys Ile Ile Ala Asp Arg Lys
 210           215           220

Ala Ser Gly Glu Gln Ser Asp Asp Leu Leu Thr His Met Leu Asn Gly
 225           230           235           240

Lys Asp Pro Glu Thr Gly Glu Pro Leu Asp Asp Glu Asn Ile Arg Tyr
      245           250           255

Gln Ile Ile Thr Phe Leu Ile Ala Gly His Glu Thr Thr Ser Gly Leu
 260           265           270

Leu Ser Phe Ala Leu Tyr Phe Leu Val Lys Asn Pro His Val Leu Gln
 275           280           285

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Lys Ala Ala Glu Glu Ala Ala Arg Val Leu Val Asp Pro Val Pro Ser
 290 295 300
 Tyr Lys Gln Val Lys Gln Leu Lys Tyr Val Gly Met Val Leu Asn Glu
 305 310 315 320
 Ala Leu Arg Leu Trp Pro Thr Ala Pro Ala Phe Ser Leu Tyr Ala Lys
 325 330 335
 Glu Asp Thr Val Leu Gly Gly Glu Tyr Pro Leu Glu Lys Gly Asp Glu
 340 345 350
 Leu Met Val Leu Ile Pro Gln Leu His Arg Asp Lys Thr Ile Trp Gly
 355 360 365
 Asp Asp Val Glu Glu Phe Arg Pro Glu Arg Phe Glu Asn Pro Ser Ala
 370 375 380
 Ile Pro Gln His Ala Phe Lys Pro Phe Gly Asn Gly Gln Arg Ala Cys
 385 390 395 400
 Ile Gly Gln Gln Phe Ala Leu His Glu Ala Thr Leu Val Leu Gly Met
 405 410 415
 Met Leu Lys His Phe Asp Phe Glu Asp His Thr Asn Tyr Glu Leu Asp
 420 425 430
 Ile Lys Glu Thr Leu Thr Leu Lys Pro Glu Gly Phe Val Val Lys Ala
 435 440 445
 Lys Ser Lys Lys Ile Pro Leu Gly Gly Ile Pro Ser Pro Ser Thr Glu
 450 455 460
 Gln Ser Ala Lys Lys Val Arg Lys Lys Ala Glu Asn Ala His Asn Thr
 465 470 475 480
 Pro Leu Leu Val Leu Tyr Gly Ser Asn Met Gly Thr Ala Glu Gly Thr
 485 490 495
 Ala Arg Asp Leu Ala Asp Ile Ala Met Ser Lys Gly Phe Ala Pro Gln
 500 505 510
 Val Ala Thr Leu Asp Ser His Ala Gly Asn Leu Pro Arg Glu Gly Ala
 515 520 525
 Val Leu Ile Val Thr Ala Ser Tyr Asn Gly His Pro Pro Asp Asn Ala
 530 535 540
 Lys Gln Phe Val Asp Trp Leu Asp Gln Ala Ser Ala Asp Glu Val Lys
 545 550 555 560
 Gly Val Arg Tyr Ser Val Phe Gly Cys Gly Asp Lys Asn Trp Ala Thr
 565 570 575
 Thr Tyr Gln Lys Val Pro Ala Phe Ile Asp Glu Thr Leu Ala Ala Lys
 580 585 590
 Gly Ala Glu Asn Ile Ala Asp Arg Gly Glu Ala Asp Ala Ser Asp Asp
 595 600 605

Phe Glu Gly Thr Tyr Glu Glu Trp Arg Glu His Met Trp Ser Asp Val
 610 615 620
 Ala Ala Tyr Phe Asn Leu Asp Ile Glu Asn Ser Glu Asp Asn Lys Ser
 625 630 635 640
 Thr Leu Ser Leu Gln Phe Val Asp Ser Ala Ala Asp Met Pro Leu Ala
 645 650 655
 Lys Met His Gly Ala Phe Ser Thr Asn Val Val Ala Ser Lys Glu Leu
 660 665 670
 Gln Gln Pro Gly Ser Ala Arg Ser Thr Arg His Leu Glu Ile Glu Leu
 675 680 685
 Pro Lys Glu Ala Ser Tyr Gln Glu Gly Asp His Leu Gly Val Ile Pro
 690 695 700
 Arg Asn Tyr Glu Gly Ile Val Asn Arg Val Thr Ala Arg Phe Gly Leu
 705 710 715 720
 Asp Ala Ser Gln Gln Ile Arg Leu Glu Ala Glu Glu Glu Lys Leu Ala
 725 730 735
 His Leu Pro Leu Ala Lys Thr Val Ser Val Glu Glu Leu Leu Gln Tyr
 740 745 750
 Val Glu Leu Gln Asp Pro Val Thr Arg Thr Gln Leu Arg Ala Met Ala
 755 760 765
 Ala Lys Thr Val Cys Pro Pro His Lys Val Glu Leu Glu Ala Leu Leu
 770 775 780
 Glu Lys Gln Ala Tyr Lys Glu Gln Val Leu Ala Lys Arg Leu Thr Met
 785 790 795 800
 Leu Glu Leu Leu Glu Lys Tyr Pro Ala Cys Glu Met Lys Phe Ser Glu
 805 810 815
 Phe Ile Ala Leu Leu Pro Ser Ile Arg Pro Arg Tyr Tyr Ser Ile Ser
 820 825 830
 Ser Ser Pro Arg Val Asp Glu Lys Gln Ala Ser Ile Thr Val Ser Val
 835 840 845
 Val Ser Gly Glu Ala Trp Ser Gly Tyr Gly Glu Tyr Lys Gly Ile Ala
 850 855 860
 Ser Asn Tyr Leu Ala Glu Leu Gln Glu Gly Asp Thr Ile Thr Cys Phe
 865 870 875 880
 Ile Ser Thr Pro Gln Ser Glu Phe Thr Leu Pro Lys Asp Pro Glu Thr
 885 890 895
 Pro Leu Ile Met Val Gly Pro Gly Thr Gly Val Ala Pro Phe Arg Gly
 900 905 910
 Phe Val Gln Ala Arg Lys Gln Leu Lys Glu Gln Gly Gln Ser Leu Gly
 915 920 925

Glu Ala His Leu Tyr Phe Gly Cys Arg Ser Pro His Glu Asp Tyr Leu
 930 935 940
 Tyr Gln Glu Glu Leu Glu Asn Ala Gln Ser Glu Gly Ile Ile Thr Leu
 945 950 955 960
 His Thr Ala Phe Ser Arg Met Pro Asn Gln Pro Lys Thr Tyr Val Gln
 965 970 975
 His Val Met Glu Gln Asp Gly Lys Lys Leu Ile Glu Leu Leu Asp Gln
 980 985 990
 Gly Ala His Phe Tyr Ile Cys Gly Asp Gly Ser Gln Met Ala Pro Ala
 995 1000 1005
 Val Glu Ala Thr Leu Met Lys Ser Tyr Ala Asp Val His Gln Val Ser
 1010 1015 1020
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 1025 1030 1035 1040
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 <220>
 <223> Description of the artificial sequence: PCR primer

 <221> unsure
 <222> 1..30
 <223> n is a or g or c or t/u, unknown, or other

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gcaggagacg ggttgnnnac aagctggacg

30

<210> 4
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<210> 5
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<212> DNA
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<220>
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gaagcaatga acaagnnnca gcgagcaaatt ccag

34

<210> 6
 <211> 34
 <212> DNA
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<220>
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34

<210> 7
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41

<210> 8
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<220>
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<222> 1..40
<223> n is a or g or c or t/u, unknown, or other
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<210> 9
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<220>
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37

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37

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37

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<220>
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37

<210> 13
 <211> 33
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<221> unsure
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33

<210> 14
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<220>
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33

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34

<210> 16

<211> 34

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<220>

<223> Description of the artificial sequence: PCR primer

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34

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<212> DNA

<213> Artificial sequence

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30